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# *Draba calcifuga* (Brassicaceae), a New Species from the Rocky Mountains of North America

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**ABSTRACT.** *Draba calcifuga* Lesica (Brassicaceae) is an alpine species of the Rocky Mountains of Montana, Idaho, and Wyoming, U.S.A., restricted to non-calcareous soils. It has been confused with the sympatric *D. oligosperma* Hooker because both species are similar in habit, leaf size and shape, fruit size and shape, style length, and in the presence of doubly pectinate trichomes on the leaves. However, *D. calcifuga* has cilia and pectinate trichomes with crisped branches that do not occur in *D. oligosperma*. *Draba calcifuga* demonstrates low pollen stainability throughout its range, suggesting it is agamospermous. Although *D. oligosperma* is agamospermous over most of its range, it is sexual in its area of sympatry with *D. calcifuga*, suggesting that the latter may be derived from the former. *Draba calcifuga* is described and compared to four other species with doubly pectinate trichomes from the Rocky Mountain region.

**Key words:** Agamospermy, Brassicaceae, *Draba*, Idaho, IUCN Red List, Montana, Wyoming.

*Draba* L. is the largest genus in the Brassicaceae with ca. 350 species occurring primarily in temperate to arctic regions (Rollins, 1993). New species continue to be described, even in relatively well-known floras (Mulligan, 1970; Dorn, 1978; Price, 1980; Al-Shehbaz & Windham, 2007). Delineation of species can be difficult due to frequent polyploidy and agamospermy. Perennial species frequently have remarkably similar growth forms and are often distinguished by trichome shape (Hitchcock, 1941; Mulligan, 1976). Four described species of *Draba* in the Rocky Mountains have doubly pectinate trichomes: *D. oligosperma* Hooker, *D. pectinipila* Rollins, *D. juniperina* Dorn, and *D. incerta* Payson (Mulligan, 1976; Dorn, 1978; Rollins, 1993). Here I describe a fifth species, *D. calcifuga* Lesica, with doubly pectinate trichomes. *Draba calcifuga* has commonly been mistaken for *D. oligosperma* because it is similar in size and has doubly pectinate trichomes on leaf surfaces. I compare it to *D. oligosperma* and other similar species occurring in the Rocky Mountains and use evidence from pollen stainability studies to propose a possible scenario for the origin of this

species. Although *D. calcifuga* is likely primarily asexual, it displays morphological, ecological, and geographical integrity, prompting me to describe it as a new species.

## METHODS

I examined 17 morphological characters considered important for separating perennial species of *Draba* in western North America (Hitchcock, 1941; Mulligan, 1976) from 28 herbarium sheets of *D. calcifuga* from southwest Montana and adjacent Wyoming. Measurements were taken from leaves, scapes, flowers, and mature fruits of representative plants on each sheet.

I used pollen stainability as a metric of agamospermy for *Draba oligosperma* and *D. calcifuga* (Radford et al., 1974; Price, 1980). I collected one anther from each of five flowers on three to five flowering specimens on herbarium sheets representing 17 populations of *D. oligosperma* and 12 populations of *D. calcifuga*. Anthers were macerated in a drop of aniline blue dye in lactophenol on a microscope slide (Radford et al., 1974). For each slide I scored 100 pollen grains from randomly chosen 100× microscope fields as either full or empty (see Mulligan & Findlay, 1970: figs. 3, 4).

## SPECIES OF *DRABA*

***Draba calcifuga*** Lesica, sp. nov. TYPE: U.S.A. Montana: Ravalli Co., Bitterroot Range, common in gravelly soil derived from metamorphic parent material in a fellfield on the summit of St. Mary's Peak with *Ivesia gordonii*, *Phlox diffusa*, and *Eritrichium nanum*, 2850 m, T9N R21W S28, 15 July 2007, P. Lesica 9819 with P. Kittelson (holotype, MONTU; isotypes, MO, MONT, NY, RM). Figure 1.

Haec species inter congeneros scaposos Montium Saxosorum trichomatibus bis pectinatis vestitos quoad scapum glabrum etiam pedicellos breves ad *Drabam oligospermam* maxime accedit, sed ab ea foliis ad marginem ciliatis et ad paginam abaxialem trichomatibus pectinatis pro parte stipitatis pubescentibus distinguitur.



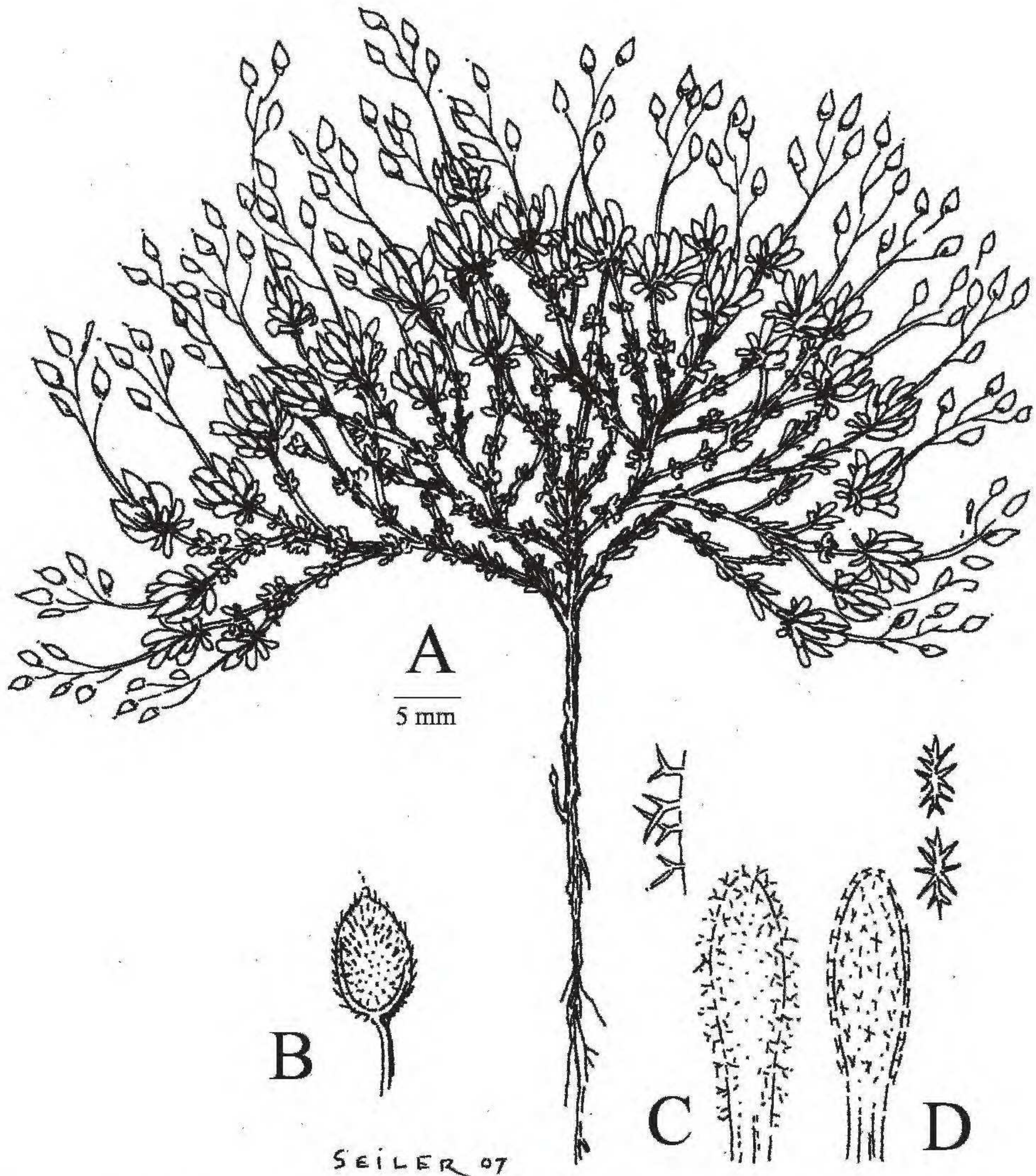


Figure 1. *Draba calcifuga* Lesica. —A. Whole plant. —B. Fruit. —C. Leaf and marginal trichomes of *D. calcifuga*. —D. Leaf and marginal trichomes of *D. oligosperma* for comparison. Drawn from the holotype, *Lesica* 9819 (MONTU).

Caespitose, scapose, perennial herbs from a taproot surmounted by a caudex, forming cushions 1–3 cm tall; caudex branches covered with old leaf bases and terminating in rosettes. Leaves oblanceolate, entire, 1.5–5.5 × 0.5–1.1 mm, tapering to a petiole-like base; abaxial surface with sessile or stalked, pectinately branched trichomes sometimes mixed with stalked, stellate trichomes; adaxial surface glabrous or with sparse simple or branched trichomes; margins ciliate with twisted simple or few-branched trichomes; scapes erect, 4–25 mm, typically glabrous or rarely with stalked-stellate trichomes. Racemes 2- to 8-flowered, ebracteate; fruiting pedicels ascending, the lowest 1.2–5 mm; sepals ovate, 1.6–3 × 0.7–1.4 mm, glabrous or with sparse twisted, simple or forked

trichomes; petals yellow, obovate, 2.3–4 × 1.2–2.1 mm, the claw 0.5–1 mm; filaments ca. 1.5 mm; anthers ca. 0.6 mm; silicles ovate, 2.5–5.3 × 1.9–3.5 mm with short, usually recurved, simple or forked trichomes 0.1–0.2 mm; fruiting style 0.2–0.6 mm; seeds 2 to 5 per silicle, 0.8–1.7 mm.

*Distribution and habitat.* *Draba calcifuga* occurs at or above treeline in non-calcareous mountain ranges in Beaverhead, Deer Lodge, Gallatin, Granite, Madison, Park, Powell, Ravalli, and Silver Bow counties in southwest Montana, Blaine and Lemhi counties in Idaho, and Park and Sublette counties in Wyoming. *Draba calcifuga* appears to be a strict calcifuge, occurring only on substrates derived from



Table 1. Morphological and habitat characters differing among four species of *Draba* with pectinate trichomes (Hitchcock, 1941; Dorn, 1978; Lichvar, 1983).

	<i>D. calcifuga</i>	<i>D. incerta</i>	<i>D. juniperina</i>	<i>D. oligosperma</i>	<i>D. pectinipila</i>
Scape trichomes	none	branched	pectinate	none	pectinate
Scape height (cm)	0.4–2.5	1–12(–20)	(5–)7–15	1–4(–9)	(4–)5–9(–11)
Pedicel length (cm)	0.1–0.5	0.6–1.8	0.5–1	0.1–0.5	0.5–1.2
Style length (mm)	0.2–0.6	0.4–1	0.7–1.5	0.1–1	0.3–0.7
Leaf cilia	simple, branched	branched	none	none	none
Leaf trichomes	sessile, stalked-pectinate	stalked- pectinate	sessile, pectinate	sessile, pectinate	sessile, pectinate
Silicle trichomes	simple, branched	simple, branched	pectinate	simple	pectinate
Silicle length (mm)	2.5–5.3	6–10	4–7	2.5–7	5–8
Chromosome number (n)	unknown	56	11	32	unknown
Habitat	alpine	alpine	montane	montane to alpine	alpine

granitic, metamorphic, and volcanic parent materials, although calcareous parent materials are common at both low and high elevations in southwest Montana and adjacent Idaho. It is most common in the granitic-batholith Bitterroot, Pioneer, Anaconda, and Tobacco Root mountain ranges in Montana. *Draba oligosperma* is also common in this part of Montana, but only at lower elevations and primarily in calcareous soils, although it has a wider ecological amplitude elsewhere (Hitchcock, 1941; Mulligan, 1972; Lesica, 2002).

*IUCN Red List category.* *Draba calcifuga* is estimated to be Least Concern (LC) according to IUCN Red List criteria (IUCN, 2001). The species occurs above timberline in habitats that are generally not impacted by human disturbance. Several known occurrences are from areas protected as designated wilderness where mechanized impacts are not allowed. Collections voucher at least 25 populations, extent of occurrence is at least 50,000 km<sup>2</sup>, and there is no reason to believe that there has been any reduction in population size.

*Phenology.* Plants flower June through July, depending on aspect and elevation. Mature fruit is present July through September.

*Etymology.* The specific epithet refers to the fact that the plant has never been collected on soils derived from calcareous parent material although such soils are common within the range of the species.

*Discussion.* *Draba calcifuga* shows little morphological variation throughout most of its range. However, one population from the Gravelly Range in Madison County, Montana (Lesica & Cooper 4929, MONTU), has nearly glabrous silicles. Several specimens from the Absaroka–Beartooth region along the Montana–Wyoming border (Beyer 6, Lackschewitz 9782, MONTU; Jennison 313, MONT; Lichvar 1895,

RM) have stalked-stellate trichomes on the scape, but otherwise conform to the description of *D. calcifuga*. These collections may represent local variants on the edge of the species' range or may indicate that *D. calcifuga* has had more than one independent origin. Such polytypy has been demonstrated for several arctic-alpine, agamospermous, perennial species of *Draba* (Brochmann et al., 1992). Understanding the relationships of *D. calcifuga* to other species will require further cytological and molecular genetics studies.

*Affinities.* Vestiture of leaves, scapes, and silicles are important in delimiting *Draba calcifuga* from the other scapose species with doubly pectinate trichomes in the Rocky Mountains (Dorn, 1978; Lichvar, 1983). *Draba pectinipila* and *D. juniperina* have sessile pectinate trichomes on the scape and silicles but lack cilia or stalked-stellate trichomes on the leaves as in *D. calcifuga*. *Draba oligosperma* has glabrous scapes and similar silicle vestiture as *D. calcifuga* but lacks cilia and stalked trichomes on the leaves. *Draba incerta* has stalked-pectinate trichomes and ciliate margins but has larger fruits than any of these other species (Table 1). These species have usually been considered closely related because of the trichome similarities (Hitchcock, 1941; Lichvar, 1983; Rollins, 1993). However, *D. oligosperma* and *D. juniperina* have different chromosome base numbers ( $x = 8$  vs.  $x = 11$ , respectively; Windham, 2000). A recent molecular phylogeny based on ITS sequences suggests that *D. oligosperma* and *D. juniperina* may not be members of the same clade (Belstein & Windham, 2003) and that doubly pectinate trichomes may have arisen independently at least twice.

*Draba calcifuga* is presumed to be agamospermous because all populations had less than 30% pollen stainability, and nine of 12 measured populations had less than 2% stainability. Pollen stainability of *D. oligosperma* populations was bimodal; 12 populations



had less than 12%, and 5 populations had more than 65% stainability. Populations of *D. oligosperma* with more than 65% stainable pollen are presumably sexual, and all occur in southwest Montana (Mulligan & Findlay, 1970), in approximate sympatry with *D. calcifuga*. Agamospermy is common in many genera of temperate vascular plants, such as *Crataegus* L., *Hieracium* L., and *Taraxacum* L., resulting in a large number of relatively homogeneous species (agamospecies sensu Richards, 1986; microspecies sensu Grant, 1971). Agamospermy has been demonstrated for several species of north-temperate *Draba* that differ from close congeners in silicle shape and vestiture (Mulligan & Findlay, 1970; Mulligan, 1976; Price, 1980). A large proportion of agamospecies have been formed following hybridization between sexual species (Stebbins, 1950; Grant, 1971; Richards, 1986; Bayer, 1987). It may not be a coincidence that the range of *D. calcifuga* broadly overlaps that of sexual *D. oligosperma*, which is agamospermous throughout most of its range. Reed Rollins (pers. comm.) suggested that *D. calcifuga* might be a hybrid between *D. oligosperma* and the sympatric *D. densifolia* Nuttall, probably because the latter is strongly ciliate, although the cilia of *D. densifolia* are simple and straight rather than branched and wavy.

*Comparative types examined.* [All specimens from GH, K, and US were viewed as high-resolution images.] U.S.A. *Draba incerta* Payson, A. Nelson & E. Nelson 5818 (GH, US); *Draba laevicapsula* Payson, Leiberg 1477 (GH, US); *Draba oligosperma* var. *andina* Nuttall, Nuttall s.n. (US); *Draba oligosperma* var. *leiocarpa* O. E. Schulz, Blankenship 50 (MONT); *Draba oligosperma* var. *microcarpa* Blankenship, Blankenship 9617 (MONT); *Draba saximontana* A. Nelson, Nelson 4323 (GH, US). CANADA. *Draba oligosperma* Hooker, Richardson s.n. (K).

*Paratypes.* U.S.A. **Idaho:** Lemhi Co., Beaverhead Mtns., Elk Mtn., R. Moseley 334 (ID); Lemhi Range, W of Meadow Lake, S. Brunsfield & P. Brunsfield 103a (ID); Blaine Co., Pioneer Mtns., Laidlaw Creek, R. Moseley 2785 (ID). **Montana:** Beaverhead Co., Pioneer Range, Tweedy Mtn., P. Lesica 1615 (MONTU); Comet Mtn., K. Lackschewitz 9572 (MONTU); Keokirk Mtn., P. Lesica 5537 (MONTU); Deerlodge Co., Anaconda Range, E Pintlar Peak, K. Lackschewitz 6859 (MONTU); Gallatin Co., Madison Range, Table Mtn., P. Lesica 2247 (MONTU); Spanish Peaks, 1901, Vogel s.n. (MONT); Granite Co., Anaconda Range, plateau W of Storm Lake, K. Lackschewitz 3779 (MONTU); Park Co., Beartooth Range, W Boulder Plateau, K. Lackschewitz 9766 (MONTU); Powell Co., Flint Creek Range, P. Lesica 9478 (MONTU); Ravalli Co., Bitterroot Range, Boulder Peak, K. Lackschewitz 617 (MONTU); Sweeney Peak, K. Lackschewitz 1281 (MONTU); St. Mary's Peak, Arno 1087 (MONTU); Silver Bow Co., Highland Mtns., Table Mtn., D. Woodland 1132 (MONTU). **Wyoming:** Park Co., Beartooth Range, Gardner Lake Overlook, P. Lesica 1506 (MONTU); Yellowstone Natl. Park, Dunraven Pass, P. Hawkins 619 (MONT); Sublette Co., Wind River Range, Union Peak, Fertig 4283 (RM).

KEY TO THE ROCKY MOUNTAIN SPECIES OF *DRABA* WITH PECTINATE TRICHOMES

- 1a. Leaf margins with simple or forked cilia . . . . . 2
- 1b. Leaves not ciliate . . . . . 3
- 2a. Silicles 2.5–5.3 mm; scapes usually glabrous, < 3 cm . . . . . *D. calcifuga*
- 2b. Silicles > 6 mm; scapes often > 3 cm with branched trichomes . . . . . *D. incerta*
- 3a. Scape glabrous; silicles with mainly simple trichomes . . . . . *D. oligosperma*
- 3b. Scape with pectinate trichomes; silicles with mainly branched trichomes . . . . . 4
- 4a. Style 0.3–0.7 mm; petals white, mostly 3–4 mm . . . . . *D. pectinipila*
- 4b. Style 0.7–1.5 mm; petals yellow, mostly 4–5 mm . . . . . *D. juniperina*

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